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TRANSMITTAL FORM (to be used for all correspondence after initial filing)	Application Number	10/540,362
	Filing Date	June 23, 2005
	First Named Inventor	Viatcheslav Dmitrievich Shapovalov
	Art Unit	1742
	Examiner Name	Not yet assigned
Total Number of Pages in This Submission	Attorney Docket Number	0065.0001US1

ENCLOSURES (Check all that apply)		
<input type="checkbox"/> Fee Transmittal Form <input type="checkbox"/> Fee Attached <input type="checkbox"/> Amendment/Reply <input type="checkbox"/> After Final <input type="checkbox"/> Affidavits/declaration(s) <input type="checkbox"/> Extension of Time Request <input type="checkbox"/> Express Abandonment Request <input type="checkbox"/> Information Disclosure Statement <input checked="" type="checkbox"/> Certified Copy of Priority Document(s) <input type="checkbox"/> Reply to Missing Parts/ Incomplete Application <input type="checkbox"/> Reply to Missing Parts under 37 CFR 1.52 or 1.53	<input type="checkbox"/> Drawing(s) <input type="checkbox"/> Licensing-related Papers <input type="checkbox"/> Petition <input type="checkbox"/> Petition to Convert to a Provisional Application <input type="checkbox"/> Power of Attorney, Revocation <input type="checkbox"/> Change of Correspondence Address <input type="checkbox"/> Terminal Disclaimer <input type="checkbox"/> Request for Refund <input type="checkbox"/> CD, Number of CD(s) _____ <input type="checkbox"/> Landscape Table on CD	<input type="checkbox"/> After Allowance Communication to TC <input type="checkbox"/> Appeal Communication to Board of Appeals and Interferences <input type="checkbox"/> Appeal Communication to TC (Appeal Notice, Brief, Reply Brief) <input type="checkbox"/> Proprietary Information <input type="checkbox"/> Status Letter <input type="checkbox"/> Other Enclosure(s) (please identify below): Return receipt postcard
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SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT			
Firm Name	Houston Eliseeva LLP		
Signature			
Printed name	Maria M. Eliseeva		
Date	June 8, 2006	Reg. No.	43,328

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ПАТЕНТАМ И ТОВАРНЫМ ЗНАКАМ



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Наш № 20/12-490

«27» июня 2005 г.

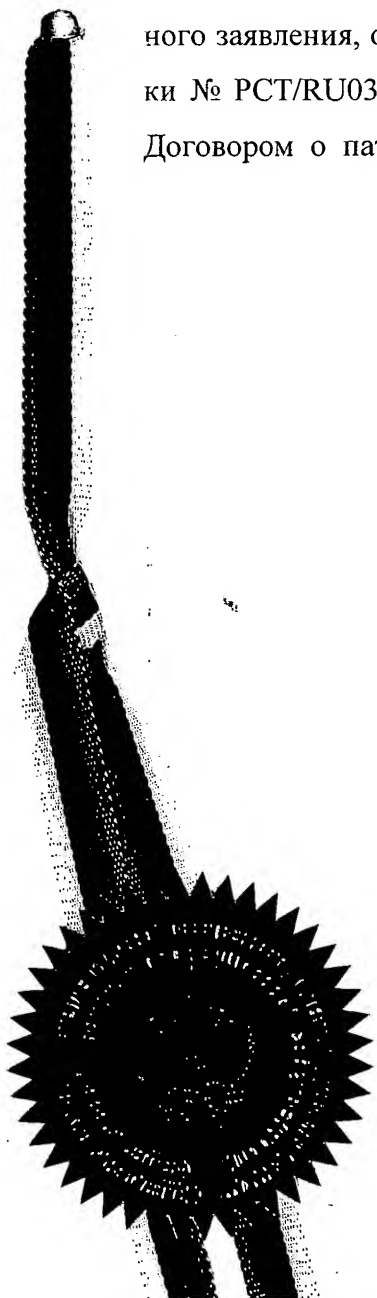
СПРАВКА

Федеральный институт промышленной собственности (далее - Институт) настоящим удостоверяет, что приложенные материалы являются точным воспроизведением первоначального заявления, описания, формулы, реферата и чертежей (если имеются) международной заявки № РСТ/RU03/00131, поданной в Институт как в Получающее ведомство в соответствии с Договором о патентной кооперации в апреле месяце 2 дня 2003 года (02.04.2003).

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PRIORITY DOCUMENT

Заведующий отделом 20

А.Л.Журавлев



Продолжение графы III ДРУГИЕ ЗАЯВИТЕЛИ И/ИЛИ (ДРУГИЕ) ИЗОБРЕТАТЕЛИ	
Если ни одна из следующих подграф не используется, этот лист не включается в заявление	
<p>Имя и адрес: (Фамилия указывается перед именем; для юридического лица - полное уставное наименование. Адрес должен включать почтовый индекс и название страны. Если государство местожительства внизу не будет указано, то таковым будет считаться страна указанного в данной графе адреса.)</p> <p>ШОХИН Александр Николаевич Россия, 103009, Москва, 1-й Тружеников пер., д. 17, кв. 29</p> <p>SHOKHIN Aleksandr Nikolaevich RU, 103009, Moscow, 1-Trudennikov per. d. 17, kv. 29</p>	<p>Данное лицо является:</p> <p>только заявителем</p> <p><input checked="" type="checkbox"/> заявителем и изобретателем</p> <p>только изобретателем</p> <p>(если помечено здесь, то не требуется заполнять ниже)</p>
Государство (т.е. страна) гражданства: RU	Государство (т.е. страна) местожительства: RU
<p>Данное лицо является заявителем для: <input checked="" type="checkbox"/> всех указанных государств <input type="checkbox"/> всех указанных государств, кроме США <input type="checkbox"/> только США <input type="checkbox"/> государств, указанных в дополнительной графе</p>	
<p>Имя и адрес: (Фамилия указывается перед именем; для юридического лица - полное уставное наименование. Адрес должен включать почтовый индекс и название страны. Если государство местожительства внизу не будет указано, то таковым будет считаться страна указанного в данной графе адреса.)</p>	<p>Данное лицо является:</p> <p>только заявителем</p> <p>заявителем и изобретателем</p> <p>только изобретателем</p> <p>(если помечено здесь, то не требуется заполнять ниже)</p>
Государство (т.е. страна) гражданства: [RU] ⁴⁴	Государство (т.е. страна) местожительства:
<p>Данное лицо является заявителем для: <input type="checkbox"/> всех указанных государств <input type="checkbox"/> всех указанных государств, кроме США <input type="checkbox"/> только США <input type="checkbox"/> государств, указанных в дополнительной графе</p>	
<p>Имя и адрес: (Фамилия указывается перед именем; для юридического лица - полное уставное наименование. Адрес должен включать почтовый индекс и название страны. Если государство местожительства внизу не будет указано, то таковым будет считаться страна указанного в данной графе адреса.)</p>	<p>Данное лицо является:</p> <p>только заявителем</p> <p>заявителем и изобретателем</p> <p>только изобретателем</p> <p>(если помечено здесь, то не требуется заполнять ниже)</p>
Государство (т.е. страна) гражданства: [RU] ⁴⁴	Государство (т.е. страна) местожительства:
<p>Данное лицо является заявителем для: <input type="checkbox"/> всех указанных государств <input type="checkbox"/> всех указанных государств, кроме США <input type="checkbox"/> только США <input type="checkbox"/> государств, указанных в дополнительной графе</p>	
<p>Имя и адрес: (Фамилия указывается перед именем; для юридического лица - полное уставное наименование. Адрес должен включать почтовый индекс и название страны. Если государство местожительства внизу не будет указано, то таковым будет считаться страна указанного в данной графе адреса.)</p>	<p>Данное лицо является:</p> <p>только заявителем</p> <p>заявителем и изобретателем</p> <p>только изобретателем</p> <p>(если помечено здесь, то не требуется заполнять ниже)</p>
Государство (т.е. страна) гражданства:	Государство (т.е. страна) местожительства:
<p>Данное лицо является заявителем для: <input type="checkbox"/> всех указанных государств <input type="checkbox"/> всех указанных государств, кроме США <input type="checkbox"/> только США <input type="checkbox"/> государств, указанных в дополнительной графе</p>	
<p><input type="checkbox"/> Другие заявители и/или (другие) изобретатели названы на листе для продолжения.</p>	

Графа V УКАЗАНИЕ ГОСУДАРСТВ Пометьте нужные боксы ниже, должен быть отмечен как минимум один бокс

Настоящим делаются следующие указания в соответствии с правилом 4.9(a):

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- ☒ **AP** Патент ARIPO: GH Гана, GM Гамбия, KE Кения, LS Лесото, MW Малави, MZ Мозамбик, SD Судан, SL Сьерра-Леоне, SZ Свазиленд, TZ Объединенная Республика Танзания, UG Уганда, ZH Замбия, ZW Зимбабве, а также любое другое государство, являющееся Договаривающимся государством Протокола Хараре и PCT (если испрашивается иной вид охраны или статус, написать на пунктирной линии):
- ☒ **EA** Евразийский патент: AM Армения, AZ Азербайджан, BY Беларусь, KG Кыргызстан, KZ Казахстан, MD Республика Молдова, RU Российская Федерация, TJ Таджикистан, TM Туркменистан, а также любое другое государство, являющееся Договаривающимся государством Евразийской патентной конвенции и PCT
- ☒ **EP** Европейский патент: AT Австрия, BE Бельгия, BG Болгария, CH и LI Швейцария и Лихтенштейн, CY Кипр, CZ Чешская республика, DE Германия, DK Дания, EE Эстония, ES Испания, FI Финляндия, FR Франция, GB Великобритания, GR Греция, IE Ирландия, IT Италия, LU Люксембург, MC Монако, NL Нидерланды, PT Португалия, SE Швеция, SI Словения, SK Словакия, TR Турция, а также любое другое государство, являющееся Договаривающимся государством Европейской патентной конвенции и PCT
- ☒ **OA** Патент ОАПИ: BF Буркина Фасо, BJ Бенин, CF Центральная Африканская республика, CG Конго, CI Кот д'Ивуар, CM Камерун, GA Габон, GN Гвинея, GQ Экваториальная Гвинея, GW Гвинея-Бисау, ML Мали, MR Мавритания, NE Нигер, SN Сенегал, TD Чад, TG Того а также любое другое государство, являющееся членом ОАПИ и Договаривающимся государством PCT (если испрашивается иной вид охраны или статус, написать на пунктирной линии):




Национальный патент (если испрашивается иной вид охраны или статус, написать на пунктирной линии):

- | | | |
|---|---|---|
| <input checked="" type="checkbox"/> AE Объединенные Арабские Эмираты..... | <input checked="" type="checkbox"/> GM Гамбия | <input checked="" type="checkbox"/> OM Оман |
| <input checked="" type="checkbox"/> AG Антигуа и Барбуда | <input checked="" type="checkbox"/> HR Хорватия | <input checked="" type="checkbox"/> PH Филиппины |
| <input checked="" type="checkbox"/> AL Албания | <input checked="" type="checkbox"/> HU Венгрия | <input checked="" type="checkbox"/> PL Польша |
| <input checked="" type="checkbox"/> AM Армения | <input checked="" type="checkbox"/> ID Индонезия | <input checked="" type="checkbox"/> PT Португалия |
| <input checked="" type="checkbox"/> AT Австрия | <input checked="" type="checkbox"/> IL Израиль | <input checked="" type="checkbox"/> RO Румыния |
| <input checked="" type="checkbox"/> AU Австралия | <input checked="" type="checkbox"/> IN Индия | <input checked="" type="checkbox"/> RU Российская Федерация |
| <input checked="" type="checkbox"/> AZ Азербайджан | <input checked="" type="checkbox"/> IS Исландия | <input checked="" type="checkbox"/> SC Сейшелы |
| <input checked="" type="checkbox"/> BA Босния и Герцеговина..... | <input checked="" type="checkbox"/> JP Япония | <input checked="" type="checkbox"/> SD Судан |
| <input checked="" type="checkbox"/> BB Барбадос | <input checked="" type="checkbox"/> KE Кения | <input checked="" type="checkbox"/> SE Швеция |
| <input checked="" type="checkbox"/> BG Болгария | <input checked="" type="checkbox"/> KG Кыргызстан | <input checked="" type="checkbox"/> SG Сингапур |
| <input checked="" type="checkbox"/> BR Бразилия..... | <input checked="" type="checkbox"/> KP Корейская народно-демократическая республика | <input checked="" type="checkbox"/> SK Словакия |
| <input checked="" type="checkbox"/> BY Беларусь | <input checked="" type="checkbox"/> KR Республика Корея | <input checked="" type="checkbox"/> SL Сьерра-Леоне |
| <input checked="" type="checkbox"/> BZ Белиз | <input checked="" type="checkbox"/> KZ Казахстан | <input checked="" type="checkbox"/> TJ Таджикистан |
| <input checked="" type="checkbox"/> CA Канада | <input checked="" type="checkbox"/> LC Сент-Люсия | <input checked="" type="checkbox"/> TM Туркменистан |
| <input checked="" type="checkbox"/> CH and LI Швейцария и Лихтенштейн | <input checked="" type="checkbox"/> LK Шри Ланка | <input checked="" type="checkbox"/> TN Тунис |
| <input checked="" type="checkbox"/> CN Китай..... | <input checked="" type="checkbox"/> LR Либерия | <input checked="" type="checkbox"/> TR Турция |
| <input checked="" type="checkbox"/> CO Колумбия | <input checked="" type="checkbox"/> LS Лесото | <input checked="" type="checkbox"/> TT Тринидад и Тобаго |
| <input checked="" type="checkbox"/> CR Коста Рика | <input checked="" type="checkbox"/> LT Литва | <input checked="" type="checkbox"/> TZ Танзания |
| <input checked="" type="checkbox"/> CU Куба..... | <input checked="" type="checkbox"/> LU Люксембург | <input checked="" type="checkbox"/> UA Украина..... |
| <input checked="" type="checkbox"/> CZ Чешская республика | <input checked="" type="checkbox"/> LV Латвия | <input checked="" type="checkbox"/> UG Уганда |
| <input checked="" type="checkbox"/> DE Германия | <input checked="" type="checkbox"/> MA Марокко | <input checked="" type="checkbox"/> US Соединенные Штаты Америки .. |
| <input checked="" type="checkbox"/> DK Дания | <input checked="" type="checkbox"/> MD Республика Молдова | <input checked="" type="checkbox"/> UZ Узбекистан..... |
| <input checked="" type="checkbox"/> DM Доминика | <input checked="" type="checkbox"/> MG Мадагаскар | <input checked="" type="checkbox"/> VC Сент-Винсент и Гренадин |
| <input checked="" type="checkbox"/> DZ Алжир..... | <input checked="" type="checkbox"/> MK Бывшая Югославская республика Македония..... | <input checked="" type="checkbox"/> VN Вьетнам..... |
| <input checked="" type="checkbox"/> EC Эквадор | <input checked="" type="checkbox"/> MN Монголия | <input checked="" type="checkbox"/> YU Югославия..... |
| <input checked="" type="checkbox"/> EE Эстония | <input checked="" type="checkbox"/> MW Малави | <input checked="" type="checkbox"/> ZA Южная Африка..... |
| <input checked="" type="checkbox"/> ES Испания | <input checked="" type="checkbox"/> MX Мексика | <input checked="" type="checkbox"/> ZH Замбия |
| <input checked="" type="checkbox"/> FI Финляндия | <input checked="" type="checkbox"/> MZ Мозамбик..... | <input checked="" type="checkbox"/> ZW Зимбабве..... |
| <input checked="" type="checkbox"/> GB Великобритания | <input checked="" type="checkbox"/> NO Норвегия | |
| <input checked="" type="checkbox"/> GD Гренада | <input checked="" type="checkbox"/> NZ Новая Зеландия..... | |
| <input checked="" type="checkbox"/> GE Грузия..... | | |
| <input checked="" type="checkbox"/> GH Гана | | |

Боксы, зарезервированные для указания государств, которые стали участниками PCT после выпуска данного листа

<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Упоминание о предварительных указаниях: В дополнение к указаниям, сделанным выше, заявитель, в соответствии с правилом 4.9(b), делает также все указания, допустимые в соответствии с PCT, за исключением указания (указаний), приведенного в Дополнительной графе в качестве исключенных из данного упоминания, и заявляет, что эти дополнительные указания подлежат подтверждению, и что любое указание, не подтвержденное до истечения 15 месяцев с даты приоритета, должно считаться изъятым заявителем на момент истечения этого срока. (Подтверждение (включая оплату пошлины) должно быть представлено в получающее ведомство в пределах 15-месячного срока)

Графа VI ЗАЯВЛЕНИЕ НА ПРИОРИТЕТ		Последующие притязания на приоритет приведены в дополнительной графе <input type="checkbox"/>	
Настоящим испрашивается приоритет следующей(их) предшествующей(их) заявки(ок):			
Страна (в которую или в отношении которой была подана заявка)	Дата подачи (день/месяц/год)	Номер заявки	Ведомство подачи (только для региональных и международных заявок)
(1)			
(2)			
(3)			
Пометить следующую клетку, если заверенная копия предшествующей заявки выдается ведомством, которое для настоящей международной заявки является Получающим ведомством (при условии уплаты установленной пошлины): <input type="checkbox"/> Прошу Получающее ведомство направить Международному бюро заверенные копии заявок, указанных выше под N _____			
Графа VII МЕЖДУНАРОДНЫЙ ПОИСКОВЫЙ ОРГАН			
Выбор Международного поискового органа (ISA) (Если компетентными в проведении международного поиска являются два или более международных поисковых органа, назвать один из них; можно использовать двухбуквенный код): Предшествующий поиск Заполняется, если у Международного поискового органа уже запрашивался поиск (международный, международно-национального типа или иной) и его просят по возможности основывать международный поиск на результатах ранее проведенного поиска. Просьба идентифицировать поиск либо ссылкой на соответствующую заявку (или ее перевод), либо ссылкой на заказ на поиск. Страна (или региональное ведомство): _____ Дата (день/месяц/год): _____ Номер: _____		ISA/ EP	
Графа VIII КОНТРОЛЬНЫЙ ПЕРЕЧЕНЬ; ЯЗЫК ПОДАЧИ			
Настоящая международная заявка содержит следующее количество листов: 1. заявление : 4 листов 2. описание : 12 листов 3. формула : 1 листов 4. реферат : 1 листов 5. чертежи : 10 листов Всего : 18 листов		К настоящей международной заявке приложены следующие документы: 1. отдельная подписанная доверенность 2. копия общей доверенности 3. разъяснения по поводу отсутствия подписи 4. приоритетный(е) документ(ы) 5. лист расчета пошлин 6. информация о депонировании микроорганизмов 7. перечень последовательностей нуклеотидов/аминокислот 8. прочее (указать): дискета	
Фигура № _____ чертежей (если имеются) предлагается для публикации с рефератом.			
Графа IX ПОДПИСЬ ЗАЯВИТЕЛЯ ИЛИ АГЕНТА			
Рядом с подписью назвать фамилию каждого подписавшего и указать, в каком качестве он подписал заявление, если это не очевидно из данных, приведенных в заявлении.			
В.Д.Шаповалов 		К.С.Фокин 	
		А.Н.Шохин 	

RO/RU

Заполняется получающим ведомством			
1. Дата фактического получения предполагаемой международной заявки:	02 апреля 2003 (02.04.2003)		2. Чертежи:
3. Исправленная дата при более позднем, но своевременном получении страниц или чертежей, доукомплектовывающих предполагаемую международную заявку:			<input type="checkbox"/> получены
4. Дата своевременного получения требуемых исправлений согласно статье 11(2) РСТ:			<input type="checkbox"/> не получены
Международный поисковый орган, выбранный заявителем:	ISA/ EP		6. <input type="checkbox"/> Направление копии для поиска задержано до уплаты пошлины за поиск.

Заполняется Международным бюро

Дата получения регистрационного экземпляра Международным бюро:		
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METHOD FOR RECOVERY OF NONFERROUS, RARE AND PRECIOUS METALS FROM ROBUST MINERALS

The method is referred to hydrometallurgy process and it serves for recovery of nonferrous, rare and precious metals from robust (hard to process) minerals, which may contain natural carbon or other robust compounds.

Very frequently the well-known techniques for recovery of nonferrous, rare and precious metals from robust minerals containing carbonaceous component or other robust compounds, do not provide satisfactory performance.

First of all it stems from high resistance to oxidation and high sorption activity of carbonaceous component of the minerals involving great loss of nonferrous, rare and precious metals with solid residue of processing.

In the framework of the present method ores and concentrates containing organometallic, cluster, colloid and other chemical and composite compounds, hindering the process of useful components recovery, should be classified among technologically robust minerals.

Hence, during cyanidation of robust carbonaceous ores and concentrates, for instance, no traces of precious metals are detected in solution in some cases, i.e. precious metal complexes formed as a result of interaction with cyanide are completely adsorbed by carbonaceous component in the mineral. Cyanidation in the presence of ion-exchange resins and carbons, as well as using sorption passivators like kerosene or apolar liquids, somewhat improves the recovery of precious metals but not infrequently its processing characteristics are as low.

Methods for carbonaceous ore leaching are described in the book "Precious Metals Metallurgy" by Maslenitsky et al. published in Moscow in 1987, pages 288-291 as follows: "... in some ores carbonaceous substances feature different settling capability, which complicates largely the cyanidation process. ... During cyanidation of carbonaceous ores kinetics of precious metal transfer to solution is determined by the ratio of two opposite processes, i.e. dissolution and sorption. ... Certain rate of leaching ... promotes maximum extraction ... in the course of carbonaceous ores cyanidation. The rate of sorption depends also on carbonaceous substance surface area. Optimal degree of material grinding should be maintained. Thus, one of the methods of carbonaceous ore direct cyanidation consists in arrangement of usual cyanide process, observing the optimal degree of grinding and period of contact between the ore and cyanic solution. Another method... consists in arrangement of leaching in several successive stages with solution renewal at each stage. Adsorption capacity of carbonaceous substances may be somewhat decreased by preliminary treatment of ore using flotation oils, kerosene, bituminous coal sublimation products and some other reagents.... However, the efficiency of the method is not very high. ... Cyanidation of carbonaceous ores using water-soluble organic nitriles, their actual applications not being ultimately ascertained, is of interest. Sorption leaching proved the most efficient method for cyanidation of carbonaceous ores and concentrates".

Attempts to reduce sorption activity of carbon-containing raw materials by thermal treatment in vacuum (for removing unsaturated oxides from carbon) failed to be widely used due to problems in hardware implementation, high costs of the process and low process performance.

In monograph "Solvents for Gold and Silver in Hydrometallurgy" by Mineev G.G. and Panchenko A.F. published by "Metallurgiya" (Metallurgy) Publishing House in 1994 in Moscow some problems arising from application of the known methods of leaching are mentioned in pages 192-205: "Bacterial leaching involves problems of intracellular metal accumulation, low performance of subsequent sorption leaching, build-up of biomass on the equipment". Leaching

by heterotrophic microorganism metabolism products and amino acid solutions yielded rather low results in reference to recovery into solution. Filtration leaching of gold-containing source materials necessitates recycling of productive solutions. That is why the latter shall be processed in situ, while methods of gold recovery from solutions shall feature high efficiency, simplicity of hardware implementation and no pollution of gold-free filters by other components. Hence, sorption biochemical leaching was chosen as the basic method for gold recovery from ores.

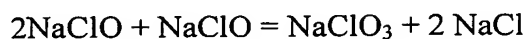
Passivation of carbon sorption activity using bacteria active life products (bacterial leaching) necessitates special fermenters for growing bacteria, fine grinding of the material, strict observance of temperature and chemical conditions, long duration of the process. In some cases, when there are great amounts of As and Sb, for instance, bacterial leaching proved impossible due to bacteria poisoning with heavy metals. Bearing in mind the above-mentioned, bacterial leaching has not been used extensively for processing robust carbonaceous minerals.

Chlorination method of precious metal recovery from ores, consisting in ore treatment by aqueous solution of hypochlorite, iron ions and acid at elevated temperature, is its immediate analog (prior art), solving the problem of precious metal recovery from robust minerals, which is described in US Patent No. 4439235 of 14.06.1982, Int.Cl.³: C22D 3\00, U.S. Cl.: 75\101 R. After filtration the solid residue is treated repeatedly by hypochlorite and iron-ion aqueous solutions at pH=7. Compounds of precious metals are extracted from liquid phase.

The prior art mentioned and the stated technical approach have the following in common: treatment of robust carbon-containing mineral with oxygen-containing oxidant and subsequent extraction of precious metal compounds from liquid phase.

Great consumption of hypochlorite for mineral oxidation, explained by the fact that hypochlorite decomposition, especially at elevated temperature, proceeds according to chlorates and chlorides formation mechanism, can be mentioned

among drawbacks of the method described. Meanwhile, hypochlorite and its disproportionation products do not take part in oxidation of precious metals and their transfer to solution:



High oxidizing activity of hypochlorites combined with their thermodynamic instability results in a very rapid decrease in effective oxidant concentration in the slurry, giving rise to high cost of processing and insufficient degree of precious metal recovery from minerals.

This invention is aimed at increasing the recovery of nonferrous, rare and precious metals from robust minerals with simultaneous reduction of processing costs.

The objective is attained, as the method for recovery of nonferrous, rare and precious metals from robust minerals envisages the processing of robust carbon-containing minerals by oxygen-containing oxidant with subsequent extraction of precious metal compounds from liquid phase, moreover, the treatment of robust carbon-containing minerals by oxygen-containing oxidant is performed in the presence of reducing agents featuring donor-acceptor properties, which are manifested in the fact that at the first stage of chemical reactions the reducing agents give their electrons to oxygen-containing oxidant and, as a result, form a stronger oxidant than the initial one, in the form of short-lived radicals and intermediate oxidation products of donor-acceptor reducing agents, which are oxidants, as well.

According to the method proposed, the treatment of robust carbon-containing minerals by oxygen-containing oxidant is realized in the presence of reducing agents featuring donor-acceptor properties. Donor-acceptor properties of the reducing agents used are pronounced in the fact that at the first stage of chemical reactions the reducing agents give their electrons to oxygen-containing oxidant and as a result form a stronger than initial oxidant, in the form of short-

lived radicals and intermediate oxidation products of donor-acceptor reducing agents, which are mild and selective oxidants.

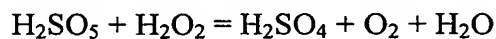
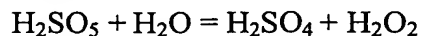
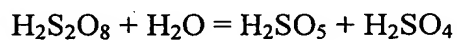
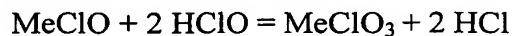
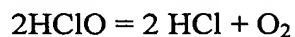
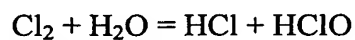
Technically, the essence of the invention proceeds from specific features of using oxygen-containing compounds as oxidants for robust minerals.

Introduction of the donor-acceptor reducing agents into hydrometallurgical process permits:

- first, directing the decomposition of oxygen-containing oxidants in line with the most favorable mechanism for oxidation of nonferrous, rare and precious metals;
- second, prolonging the action of oxidants by mediating their oxidizing potential via the reducing agents oxidation products, which are milder and more selective oxidizing agents;
- third, making use of complexing capability of the reducing agents for overcoming kinetic and electrochemical difficulties in dissolving nonferrous, rare and precious metals and stabilizing the dissolved precious metals in liquid phase;
- fourth, transforming the intermediate compounds formed as a result of oxygen-containing oxidant disproportionation into short-lived "fast radicals", permitting oxidation of organometallic, cluster, colloid and other chemical and composite compounds, which increases essentially the utilization factor of robust minerals.

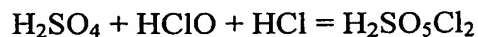
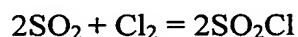
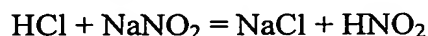
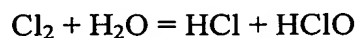
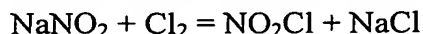
Existence of the above-mentioned mechanisms of chemical interactions is confirmed by the following theoretical and experimental data:

1) In solutions of oxygen-containing oxidants without donor-acceptor reducing agents the decomposition of oxidants proceeds by the following reactions:



It follows from the reactions presented that as a result of decomposition of oxygen-containing oxidants, not involving donor-acceptor reducing agents, the decomposition and disproportionation products are accumulated in solution along with evolution of gaseous oxygen, which are not effective oxidants under normal conditions. Accordingly, it gives rise to high consumption of oxidants and low performance of recovery process.

2) In the presence of donor-acceptor reducing agents the oxidation potential of oxygen-containing compounds is actually entirely used for the formation of short-lived radicals and reducing agent oxidation products. The following reactions take place as a result:



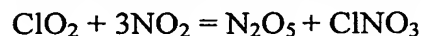
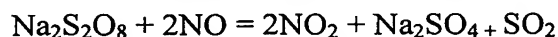
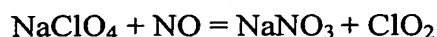
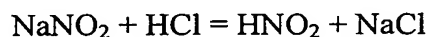
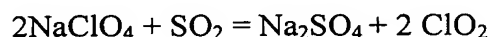
Using NaNO_2 and SO_2 by way of example, it follows from the reactions presented that interaction between the Cl_2 - HClO oxidant and donor-acceptor reducing agents gives rise to formation of many products, i.e. NaNO_3 , NOCl , NO_2Cl , HNO_2 , SO_2Cl , O_2 , $\text{H}_2\text{SO}_5\text{Cl}_2$, etc., each of them can serve an independent oxidant for nonferrous, rare and precious metals.

Meanwhile, the oxidation potentials developed by the compounds during reduction to lower valency states, fall within a wide range relative to normal hydrogen electrode. Actually all the substances feature complexing properties and form compounds with nonferrous, rare and precious metals, required for the process. The presence of various compounds featuring diverse electrochemical and complexing properties during oxidation of nonferrous, rare and precious

metals permits increasing thermodynamic probability of the metals oxidation and their transfer to solution.

Compounds of higher oxidation state, e.g. chlorates, perchlorates, persulfates, perbromates, other oxygen-containing oxidants and their derivatives have great bound chemical energy, but chemical energy cannot be used for oxidation of nonferrous, rare and precious metals owing to stability of chlorates and perchlorates as compounds and their low chemical activity.

In the invention proposed oxidants featuring the highest valency of acid residue atom, for instance, chlorates, perchlorates, persulfates, perbromates, other oxygen-containing oxidants and their derivatives are used as oxidants in the presence of donor-acceptor reducing agents. As a result, the donor-acceptor reducing agents give rise to the formation of radical, i.e. oxygen superoxide, atomic oxygen and other highly reactive compounds, including the reducing agents oxidation products, which permits effective oxidation and dissolution of nonferrous, rare and precious metals contained in the minerals, i.e.:



It becomes obvious from the reasoning above that the proposed method for recovery of precious metals differs from the known ones, as robust minerals are treated with oxygen-containing oxidants in the presence of reducing agents featuring donor-acceptor properties. Thus, the proposed method complies with the "novelty" criterion.

Comparison of the approach proposed with the prior art and other approaches in this field of engineering permitted revealing the signs, making the proposed approach different from the prior art, moreover, the differences considered are implicit, which suggests conclusion about compliance of the approach proposed with the "invention level" criterion. The approach proposed has industrial applications.

Examples of specific applications for the process proposed:

Example No. 1.

Hydrometallurgical oxidation was realized using ore featuring the following mineral composition:

a) non-metallic minerals

siderite – 18.2%, calcite – 1.0%, quartz – 8.3%, kaolin – 4.5 %,
chlorite – 1.8%, albite – 1.0%, hydromica – 1.0%, apatite – 0.3%;

b) ore mineral

goethite, limonite – 61.5%, pyrite – 1.2%, chalcopryrite – 0.85%,
bornite 0.2%, covellite 0.1%.

The ore contained gold 7.4 g/ton ore, platinum 56 g/ton ore, palladium 12 g/ton ore, and silver 150 g/ton ore, as well as copper 0.7% and cobalt 0.2%.

The ore, its amount 1 kg, was subjected to hydrometallurgical oxidation in hydrochloric acid solution, its concentration 100 g per liter, in liquid-to-solid ratio (L:S) = 3:1, at a temperature of 80°C with intense agitation.

Ammonium persulfate $(\text{NH}_4)_2\text{S}_2\text{O}_8$ was used as oxidant in the amount providing concentration of 10 g per liter, which was introduced into the slurry immediately after heating to assigned temperature. Check sample was agitated in parallel with the basic one without addition of donor-acceptor reducing agents.

Solution containing 10 g/l of sodium nitrite NaNO_2 and 10 g/l of sodium sulfite Na_2SO_3 was introduced gradually into the basic sample. The feed rate depended

on gas evolution intensity. Altogether 100 ml of solution containing donor-acceptor reducing agents was consumed in 30 minutes. Hence, 1 gram of NaNO_2 and 1 gram Na_2SO_3 was consumed per total amount of the oxidant equal to 30 grams.

The solutions prepared and solid residue were analyzed by atomic-absorption and assay analyses for ascertaining the extraction of nonferrous and precious metals into solution.

In the check sample (without addition of donor-acceptor reducing agents) the extraction into solution made up:

Copper – 73%, cobalt 68%, silver 57%, gold 64%, platinum 31%, palladium 47% of their content in the sample.

In the sample with donor-acceptor reducing agents metal extraction into solution amounted to:

Copper – 98.5%, cobalt 97%, silver 94%, gold 98.3%, platinum 94%, palladium 97%.

The results suggest that the use of donor-acceptor reducing agents increases essentially the extraction of nonferrous and precious metals from robust minerals.

Example No. 2.

Hydrometallurgical oxidation was realized using ore featuring the following mineral composition:

a) non-metallic minerals

siderite – 12.2%, calcite – 7.0%, quartz – 37.8%, kaolin – 3.7 %, chlorite – 2.8%, albite – 2.0%, hydromica – 12.0%, apatite – 0.7%, carbonaceous matter 4.5%:

b) ore minerals

goethite, limonite – 11.5%, pyrite – 3.2%, pyrrhotine – 2.5%, arsenopyrite – 0.1%.

The ore contained gold 3.4 g/ton ore, platinum 2.6 g/ton ore, palladium 3.2 g/ton ore, and silver 5 g/ton ore.

The ore, its amount 1 kg, was subjected to hydrometallurgical oxidation in hydrochloric acid solution, its concentration 10 g per liter, at L:S = 3:1, at a temperature of 40°C with intense agitation.

Sodium hypochlorite NaClO was used as oxidant in the amount providing the concentration of 5 g/l, which was introduced into the slurry immediately after heating up to the assigned temperature. The check sample was agitated in parallel with the basic one without addition of donor-acceptor reducing agents.

Solution containing 10 g/l of sodium nitrite NaNO_2 was introduced gradually into the basic sample. The feed rate depended on gas evolution intensity. Altogether 200 ml of solution containing donor-acceptor reducing agent was consumed in 30 minutes. Hence, 2 grams of NaNO_2 was consumed per total amount of the oxidant equal to 15 grams.

The solutions prepared and solid residue were analyzed by atomic-absorption and assay analyses for ascertaining the extraction of nonferrous and precious metals into solution.

In the check sample (without addition of donor-acceptor reducing agent) the extraction into solution made up: silver 37%, gold 52%, platinum 21%, palladium 37% of their content in the sample.

In the sample with donor-acceptor reducing agents metal extraction into solution amounted to:

silver 87%, gold 92.3%, platinum 74%, palladium 87%.

The results suggest that the use of donor-acceptor reducing agents increases essentially the extraction of nonferrous and precious metals from robust minerals.

Example No. 3.

Hydrometallurgical oxidation was performed using gravity concentrate featuring the following chemical composition:

SiO₂ – 23%, Al₂O₃ – 5.6%, Fe (total) – 28%, S (total) – 36%, crystallization water – 1.34%, CaO – 1.12 %, MgO – 0.8%.

The concentrate contained gold 378 g/ton ore, platinum 47 g/ton ore, palladium 126 g/ton ore, and silver 2480 g/ton ore, as well as 3.8% of nickel and 2.4% of cobalt.

The concentrate in the amount of 1 kg was subjected to hydrometallurgical oxidation in hydrochloric acid solution, its concentration 70 g per liter, at L:S = 2:1, at a temperature of 70°C under intensive agitation.

Ammonium perchlorate (NH)₄ClO₄ was used as oxidant in the amount providing concentration of 10 g per liter, and sodium iodate NaIO₃ in the amount providing concentration of 5 g per liter, were introduced into the slurry immediately after heating to assigned temperature. The check sample was agitated in parallel with the basic one without addition of donor-acceptor reducing agents.

Solution containing 10 g/l of sodium sulfite Na₂SO₃ and 5 g/l sodium thiosulfate Na₂S₂O₃ was gradually introduced in the basic sample. The feed rate depended on gas evolution intensity. In total 300 ml of solution containing donor-acceptor reducing agents was consumed in 45 minutes. So, 3 grams of Na₂SO₃ and 1.5 grams of Na₂S₂O₃ were consumed per total amount of oxidants equal to 45 grams.

The solutions prepared and solid residue were analyzed by atomic-absorption and assay analyses for ascertaining the extraction of nonferrous and precious metals into solution.

In the check sample (without addition of donor-acceptor reducing agents) the extraction into solution made up:

nickel – 63%, cobalt – 57%, silver – 48%, gold – 63%, platinum – 42%, palladium – 54% of their content in the sample.

In the sample with donor-acceptor reducing agents metal extraction into solution amounted to:

nickel – 98.5%, cobalt – 95%, silver – 89%, gold – 94%, platinum – 89%,
palladium – 92%.

The results suggest that the use of donor-acceptor reducing agents increases essentially the extraction of nonferrous and precious metals from robust minerals.

CLAIM

METHOD FOR RECOVERY OF NONFERROUS, RARE AND PRECIOUS
METALS FROM ROBUST MINERALS

The method for recovery of nonferrous, rare and precious metals from robust minerals envisages the processing of robust carbon-containing minerals by oxygen-containing oxidant with subsequent extraction of precious metal compounds from liquid phase, moreover, the treatment of robust carbon-containing minerals by oxygen-containing oxidant is performed in the presence of reducing agents featuring donor-acceptor properties, which are manifested in the fact that at the first stage of chemical reactions the reducing agents give their electrons to oxygen-containing oxidant and, as a result, form a stronger oxidant than the initial one, in the form of short-lived radicals and intermediate oxidation products of donor-acceptor reducing agents, which are oxidants, as well.

ABSTRACT

METHOD FOR RECOVERY OF NONFERROUS, RARE AND PRECIOUS
METALS FROM ROBUST MINERALS

The method is referred to hydrometallurgy process and it serves for recovery of nonferrous, rare and precious metals from robust (hard to process) minerals, which may contain natural carbon or other robust compounds.

This invention is aimed at increasing the recovery of nonferrous, rare and precious metals from robust minerals with simultaneous reduction of processing costs.

The objective is attained, as the method for recovery of nonferrous, rare and precious metals from robust minerals envisages the processing of robust carbon-containing minerals by oxygen-containing oxidant with subsequent extraction of precious metal compounds from liquid phase, moreover, the treatment of robust carbon-containing minerals by oxygen-containing oxidant is performed in the presence of reducing agents featuring donor-acceptor properties, which are manifested in the fact that at the first stage of chemical reactions the reducing agents give their electrons to oxygen-containing oxidant and, as a result, form a stronger oxidant than the initial one, in the form of short-lived radicals and intermediate oxidation products of donor-acceptor reducing agents, which are oxidants, as well.